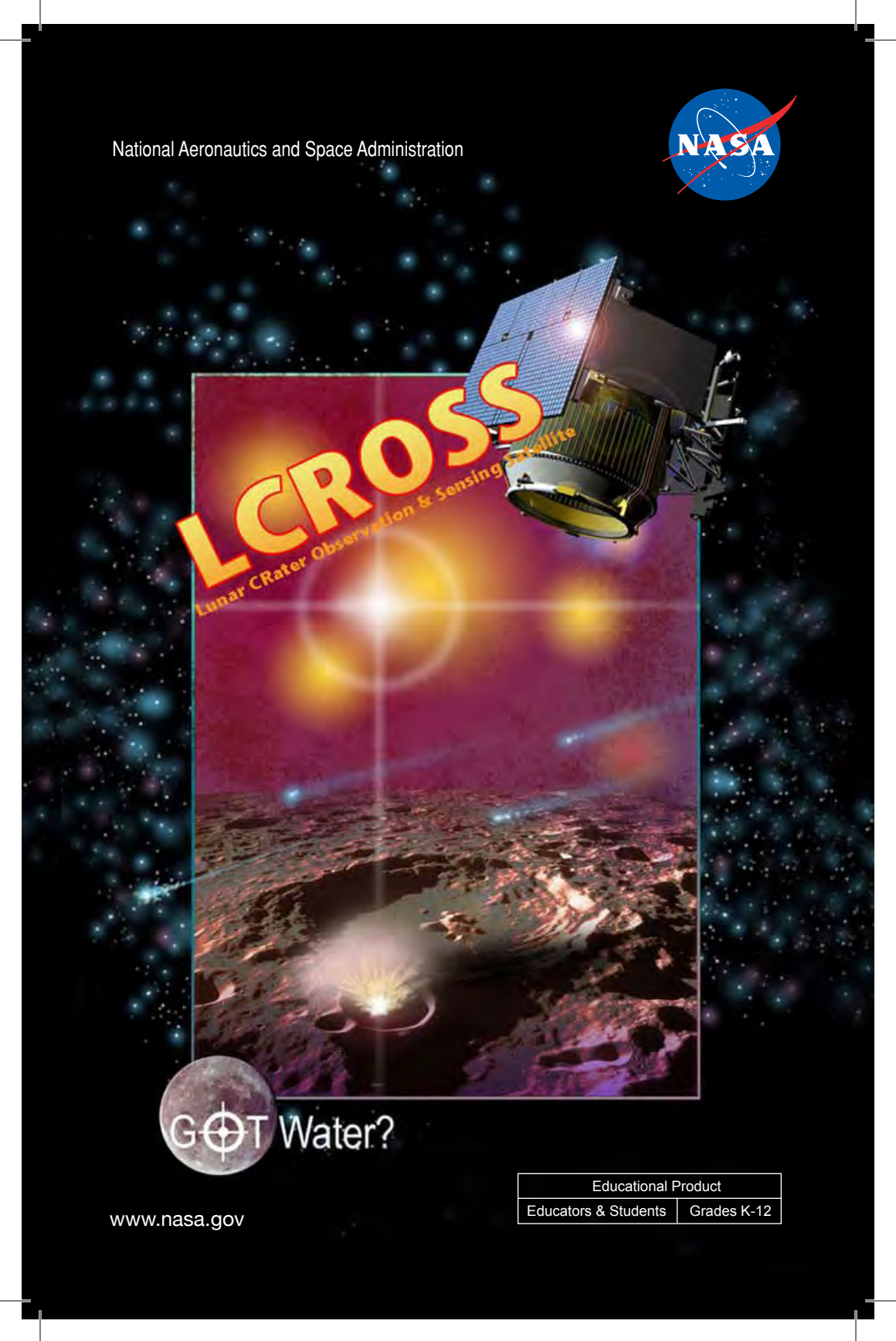
National Aeronautics and Space Administration



Educational Product	
Educators & Students	Grades K-12

www.nasa.gov

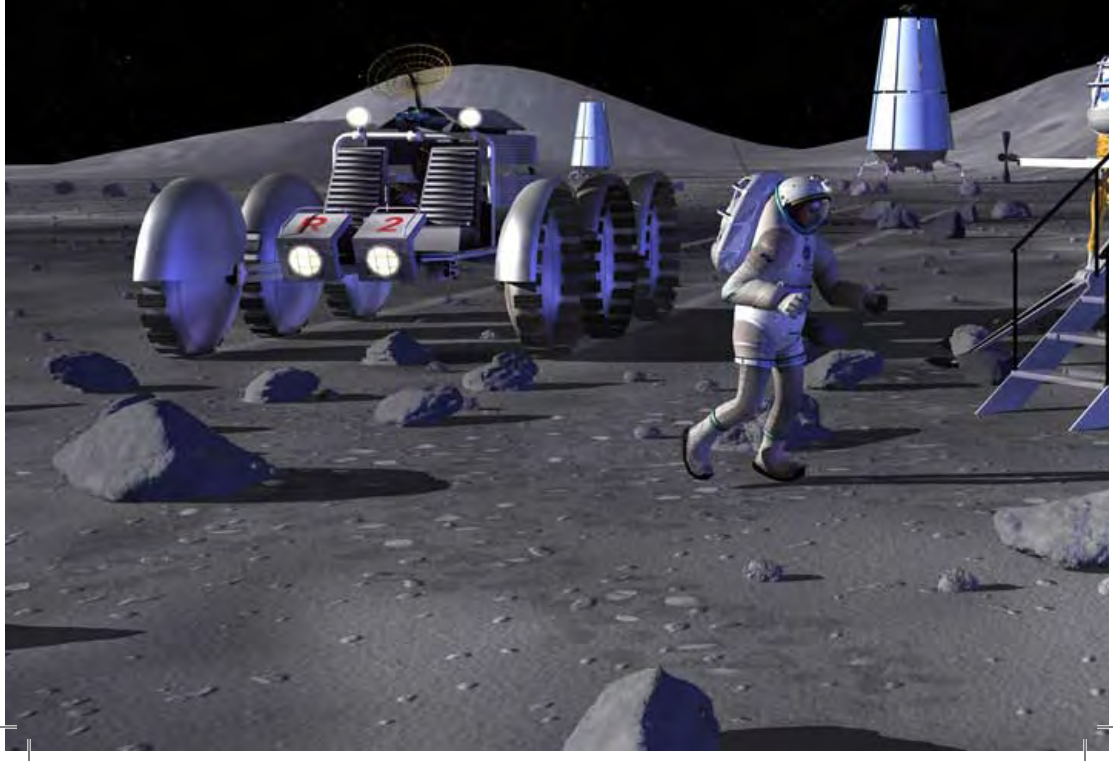
Got Water?

Just like on Earth, water is a natural resource humans will need to live on the Moon. Hauling large amounts of water to live for long periods of time would be expensive. Life in a lunar outpost could be much easier if water can be found on the Moon.

This search for water is behind NASA's LCROSS Mission. LCROSS is short for Lunar Crater Observation and Sensing Satellite.

The mission's objective is to confirm the presence or absence of water ice in a shadowed crater near a lunar pole.

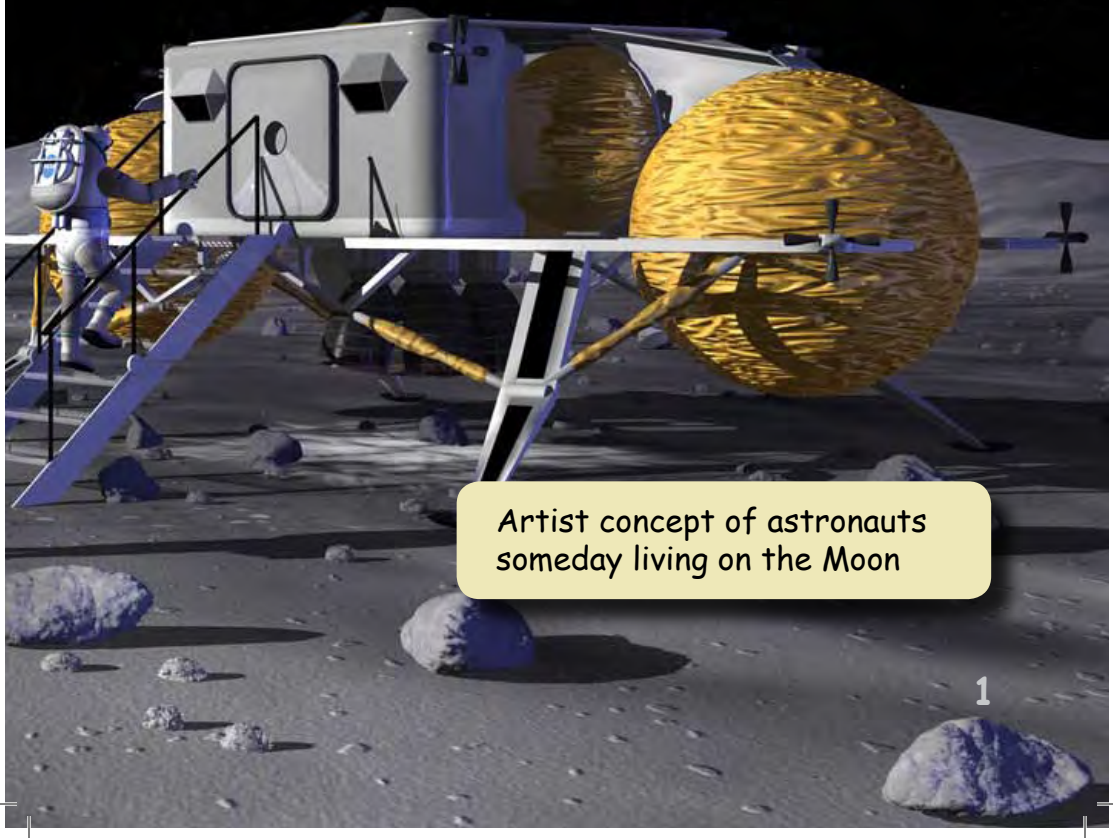
LCROSS will be launched with the Lunar Reconnaissance Orbiter (LRO) on a Atlas V rocket. Scheduled to launch in 2009, the LCROSS spacecraft will separate from the Centaur upper stage of its rocket when approaching the Moon after several months of orbits. The Centaur will be sent crashing into the Moon causing



an impact that will throw tons of debris—and potentially water ice and vapor—into a plume that will rise above the Moon's surface. During the next four minutes, the spacecraft will fly through the plume, collecting and sending data back to Earth before impacting the lunar surface and creating a second debris plume.

The debris plumes are expected to be visible from Earth-based observatories, space-based telescopes, and amateur telescopes 10-12 inches and larger.

NASA's Ames Research Center is managing the mission, performing mission operations, and has developed the payload instruments. Northrop Grumman designed and built the spacecraft for this innovative mission. NASA's Launch Services Program at NASA's Kennedy Space Center, Florida, manages the launch service including payload integration.



Artist concept of astronauts someday living on the Moon

A Thirst for Knowledge

Journeys to the Moon, planets, and beyond begin with people. Our unquenchable search for answers and knowledge is the fuel propelling our exploration of the universe.

On the LCROSS Mission, teams of scientists and engineers from NASA and Northrop Grumman have worked for years on this journey to confirm the presence or absence of water ice on the Moon.

A sample of the many questions behind the mission include:

How do we design and build a lunar mission under very tight time and money constraints?

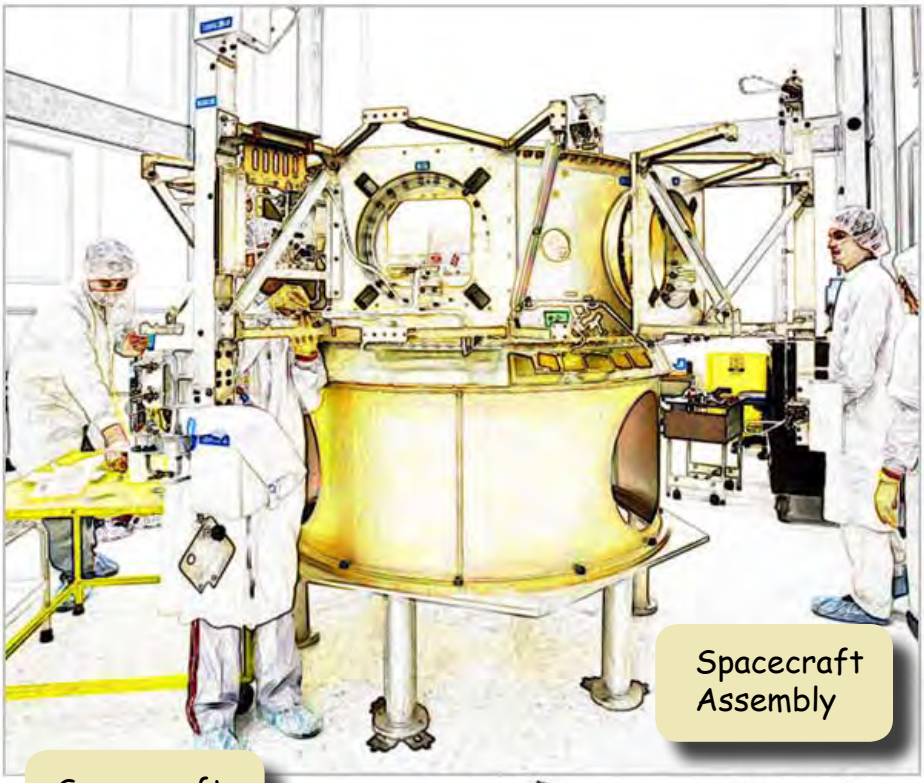
What is the right mix of instruments to go into the spacecraft?

How do we make sure the instruments will withstand the extreme environments that will be encountered along the way?

What is the best orbit to take before descending to the Moon's pole?

What data can be gathered from the trailing spacecraft?

What is learned from observing the impact from telescopes on Earth?



Spacecraft Assembly

Spacecraft Components

ESPA Ring

Batteries

Thrusters

Solar Panel not shown

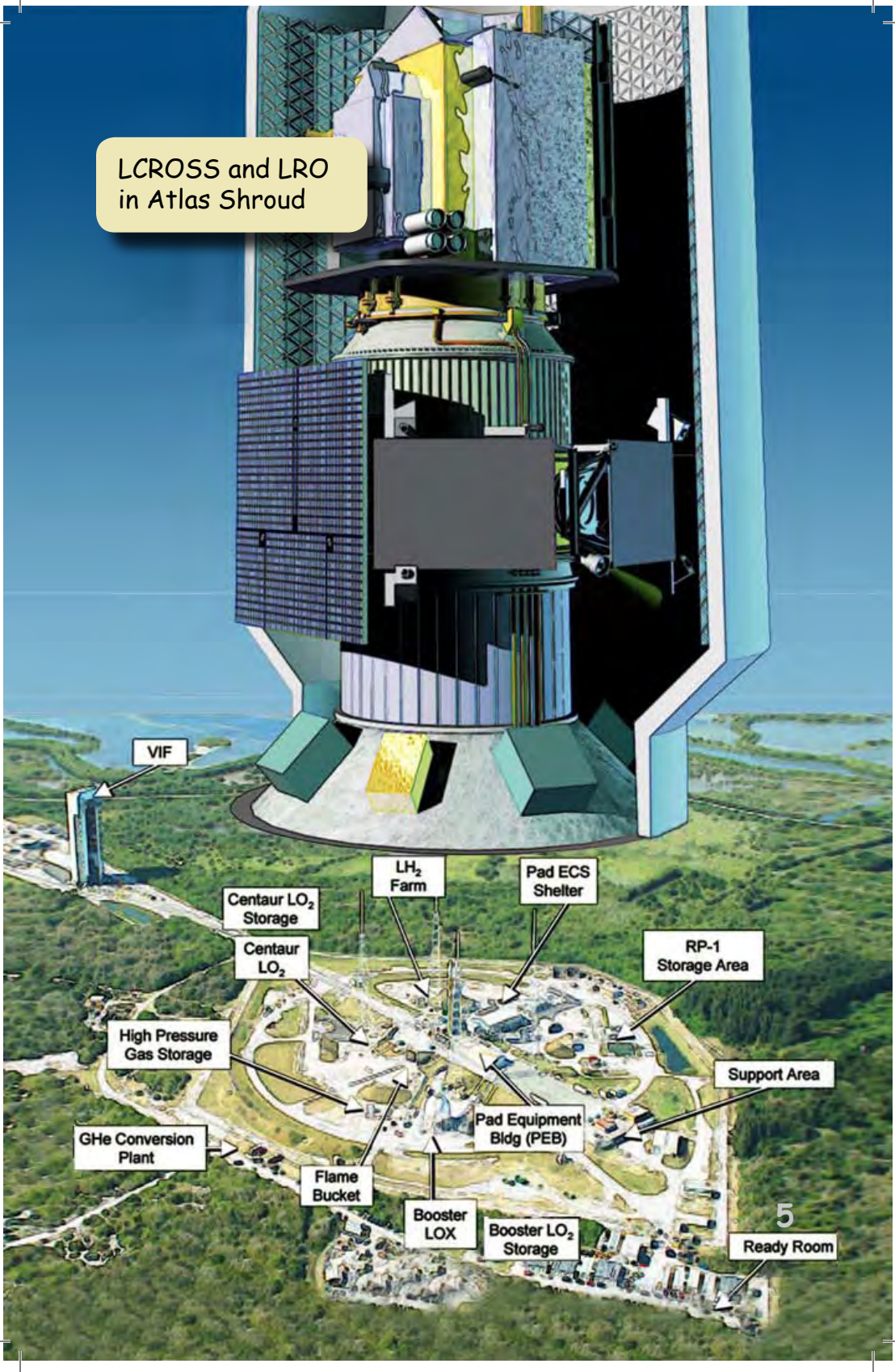
Propellant Tank

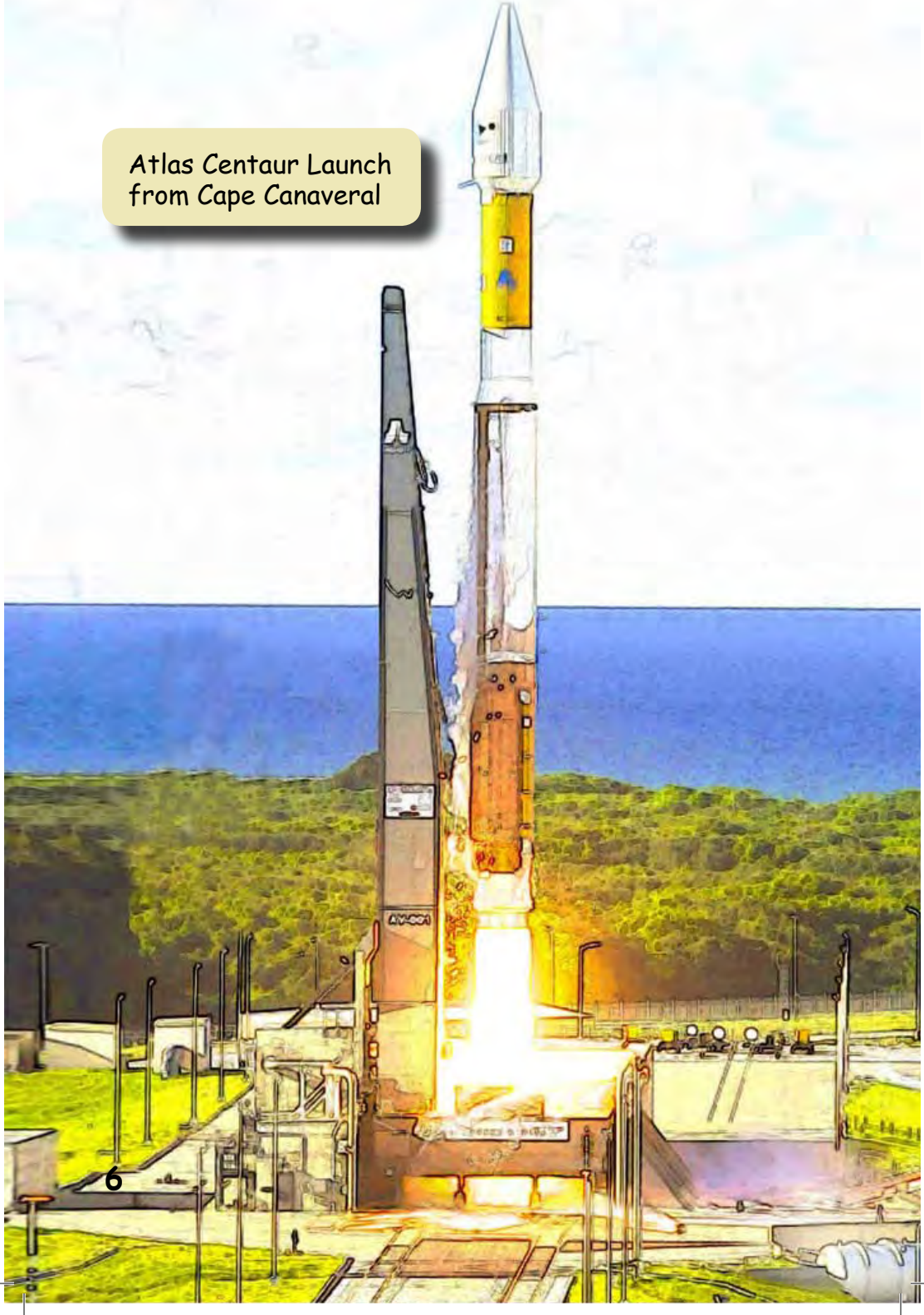
Science Instruments

Radiator Panels (5 places)

Attitude Control Electronics

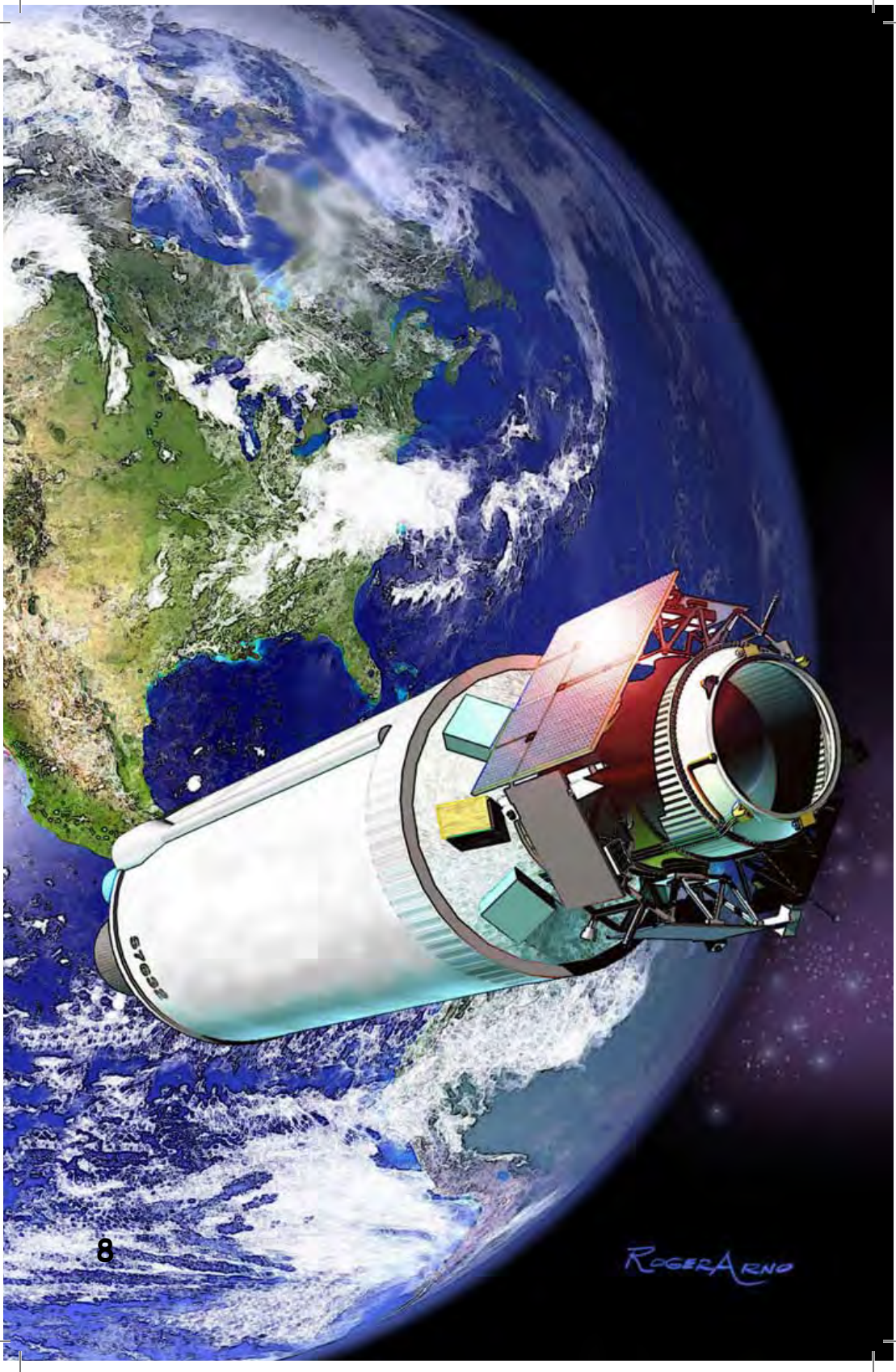

Instrument
Testing

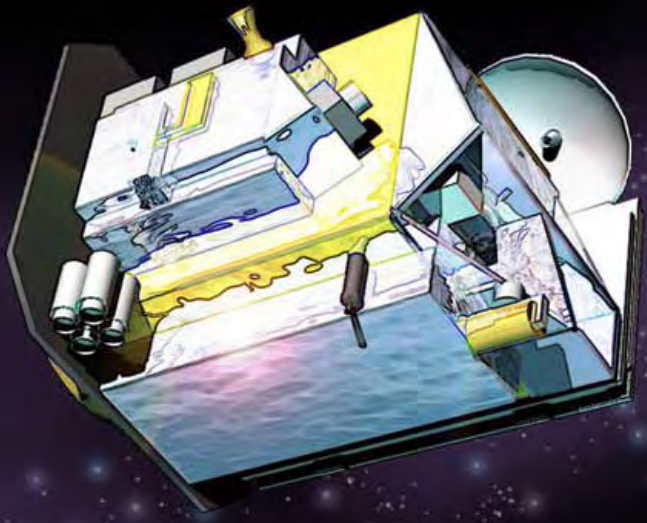

LCROSS and LRO
in Atlas Shroud
VIF
LH2
Farm
Pad ECS
Shelter
Centaur LO2
Storage
Centaur
LO2
RP-1
Storage Area
High Pressure
Gas Storage
Support Area
Pad Equipment
Bldg (PEB)
GHe Conversion
Plant
Flame
Bucket
Booster
LOX
Booster LO2
Storage
Ready Room



Atlas Centaur Launch
from Cape Canaveral

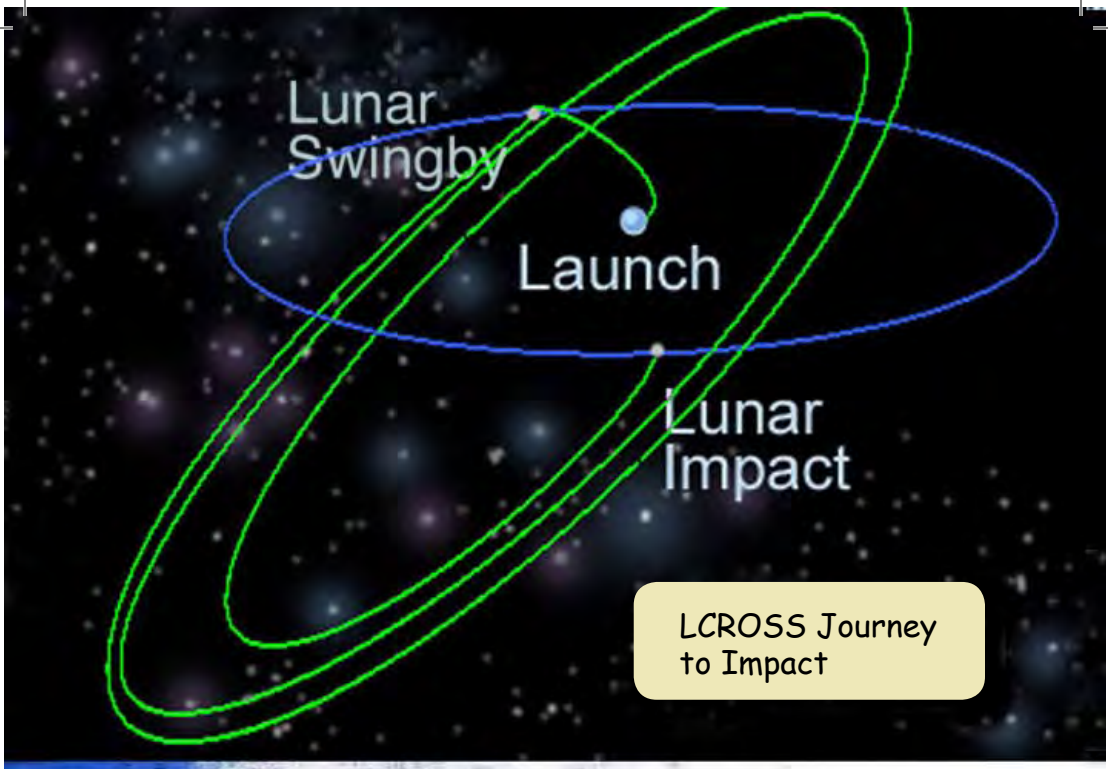
Earth Departure


ROGER ARNO

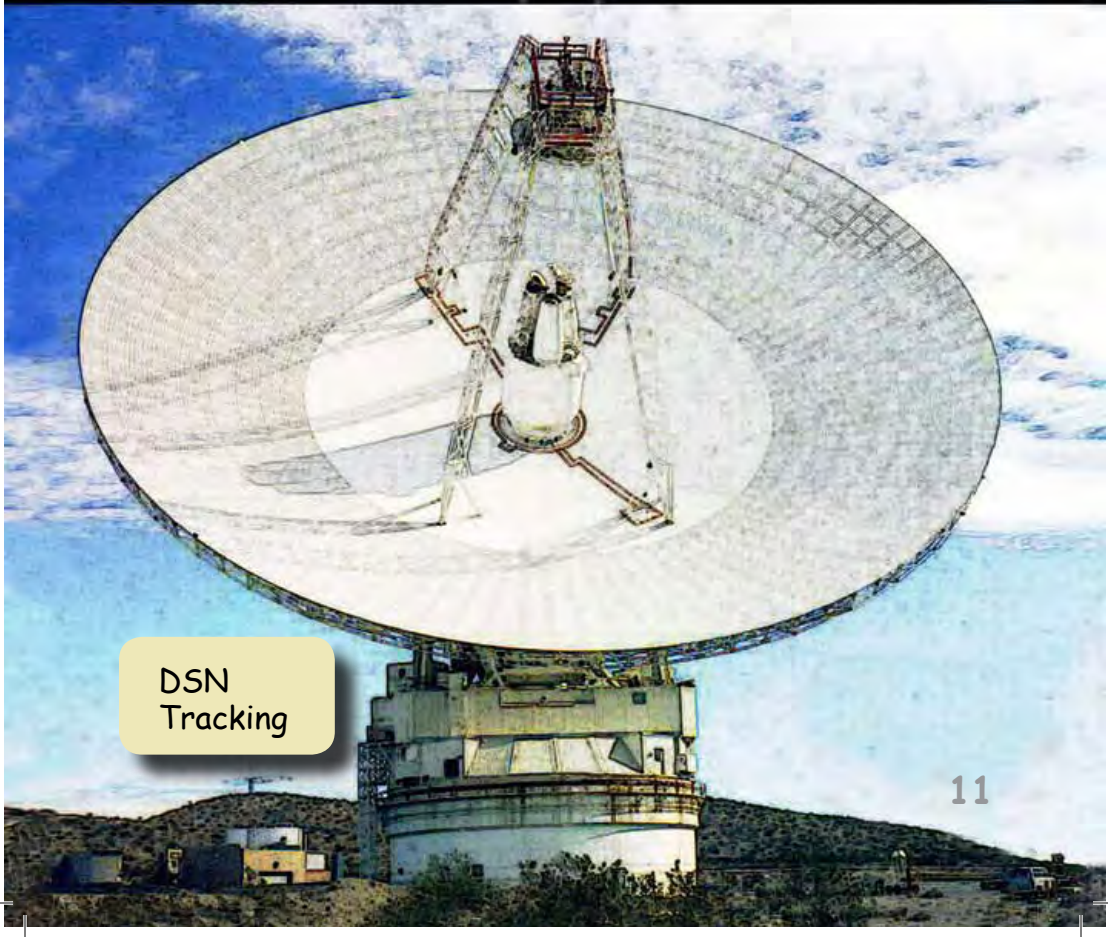


LRO is released after lunar transfer velocity is reached

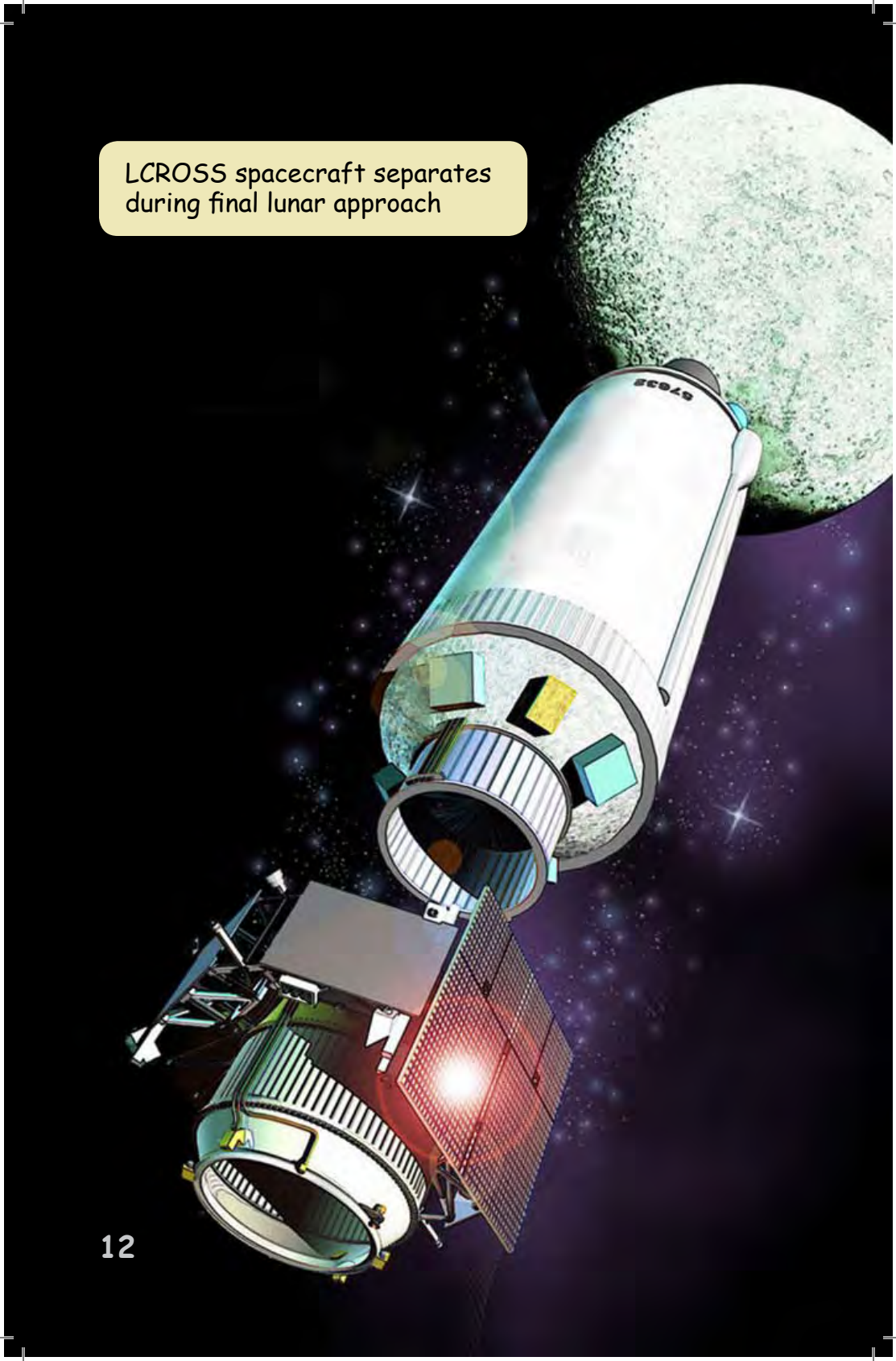
Lunar Swingby

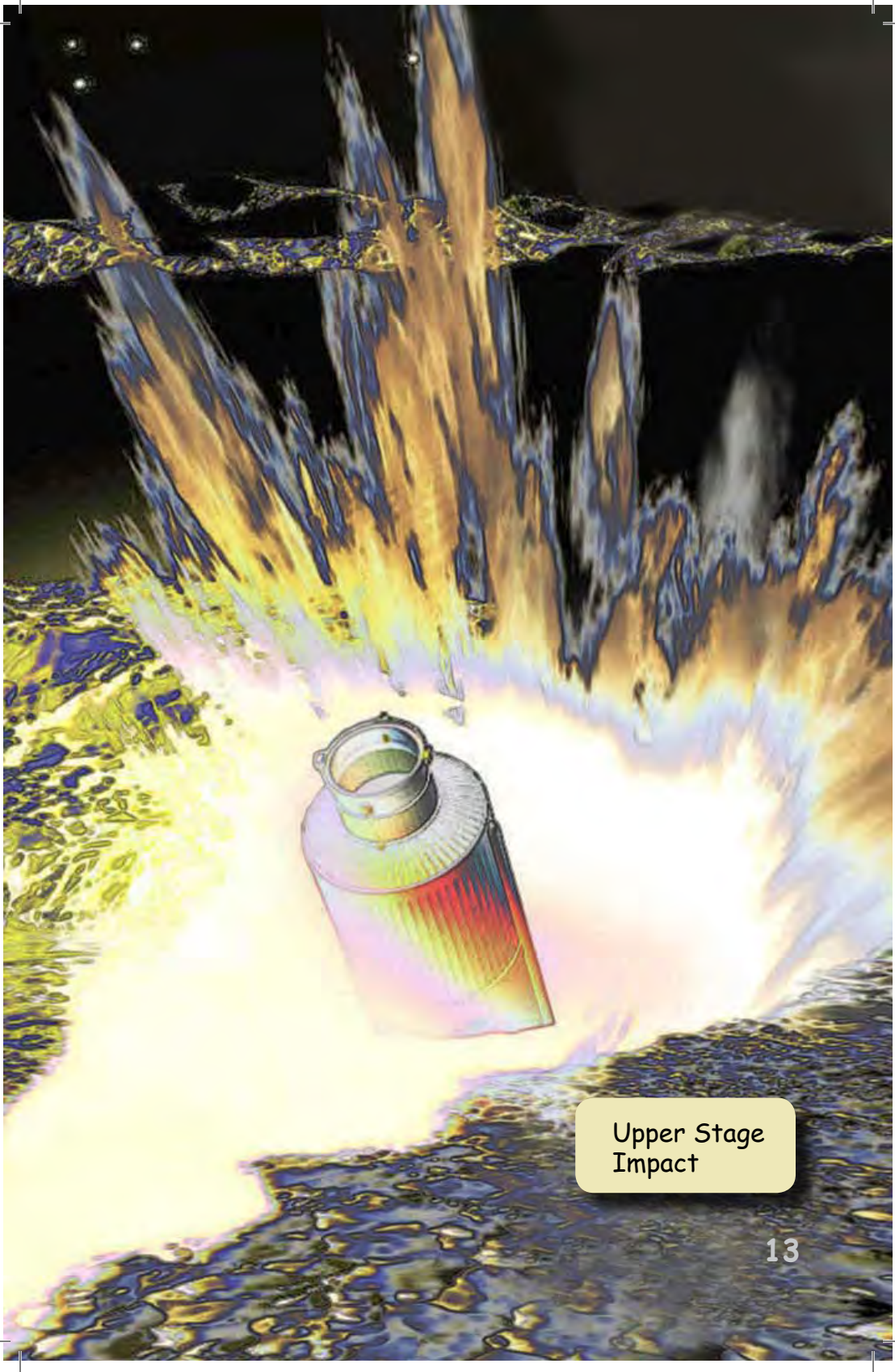


LCROSS Journey to Impact

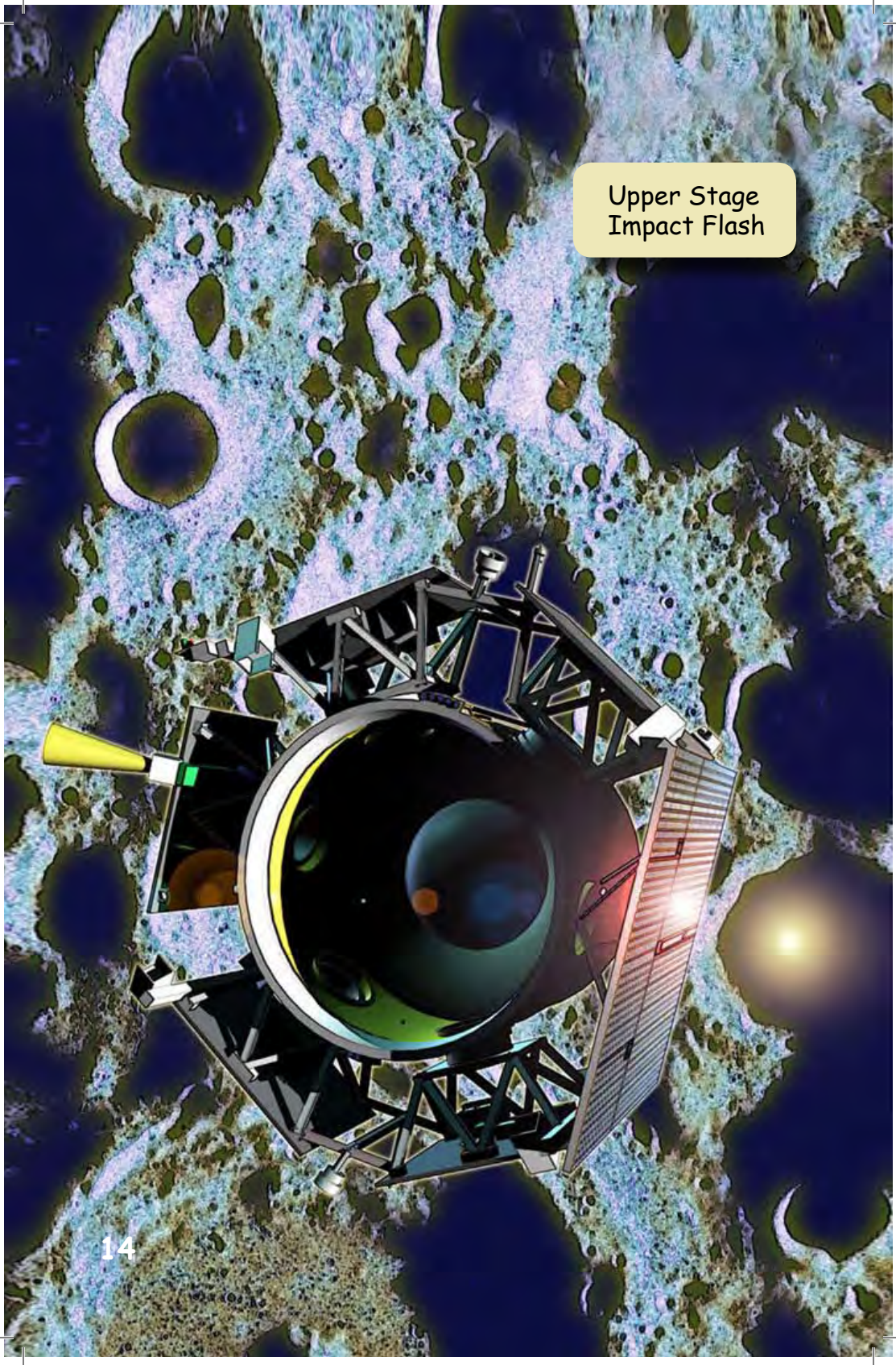


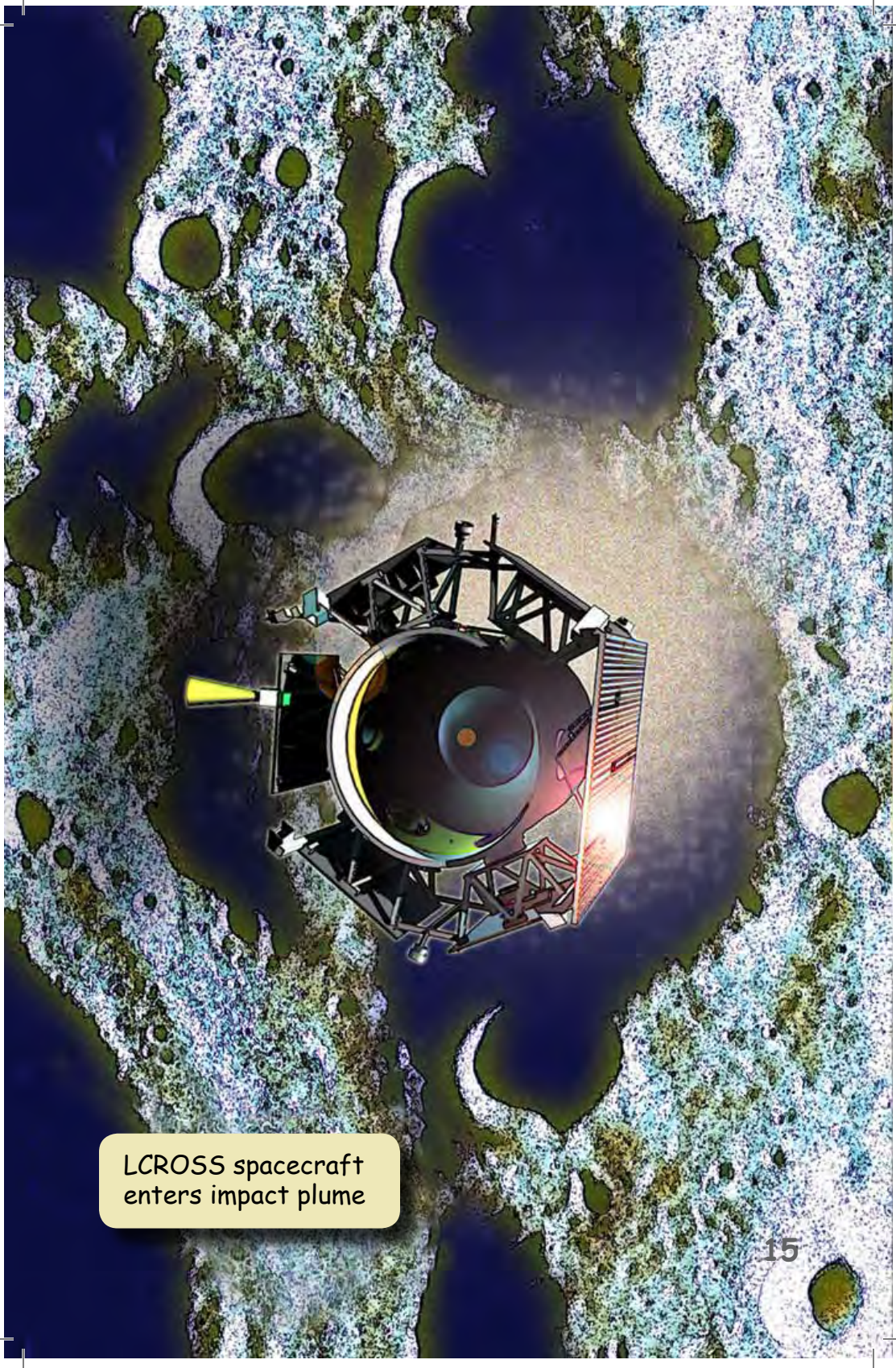
DSN Tracking


LCROSS spacecraft separates during final lunar approach

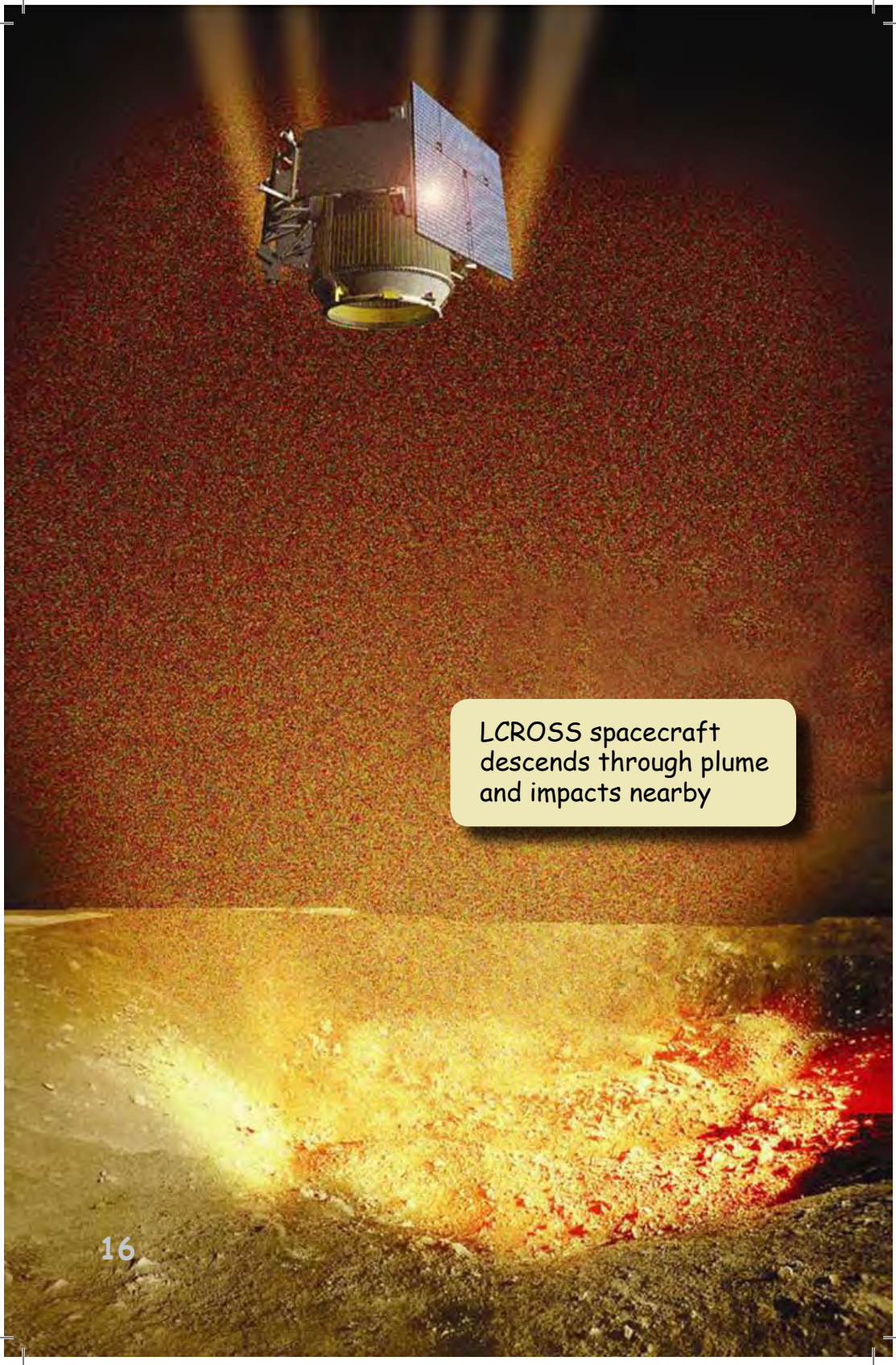


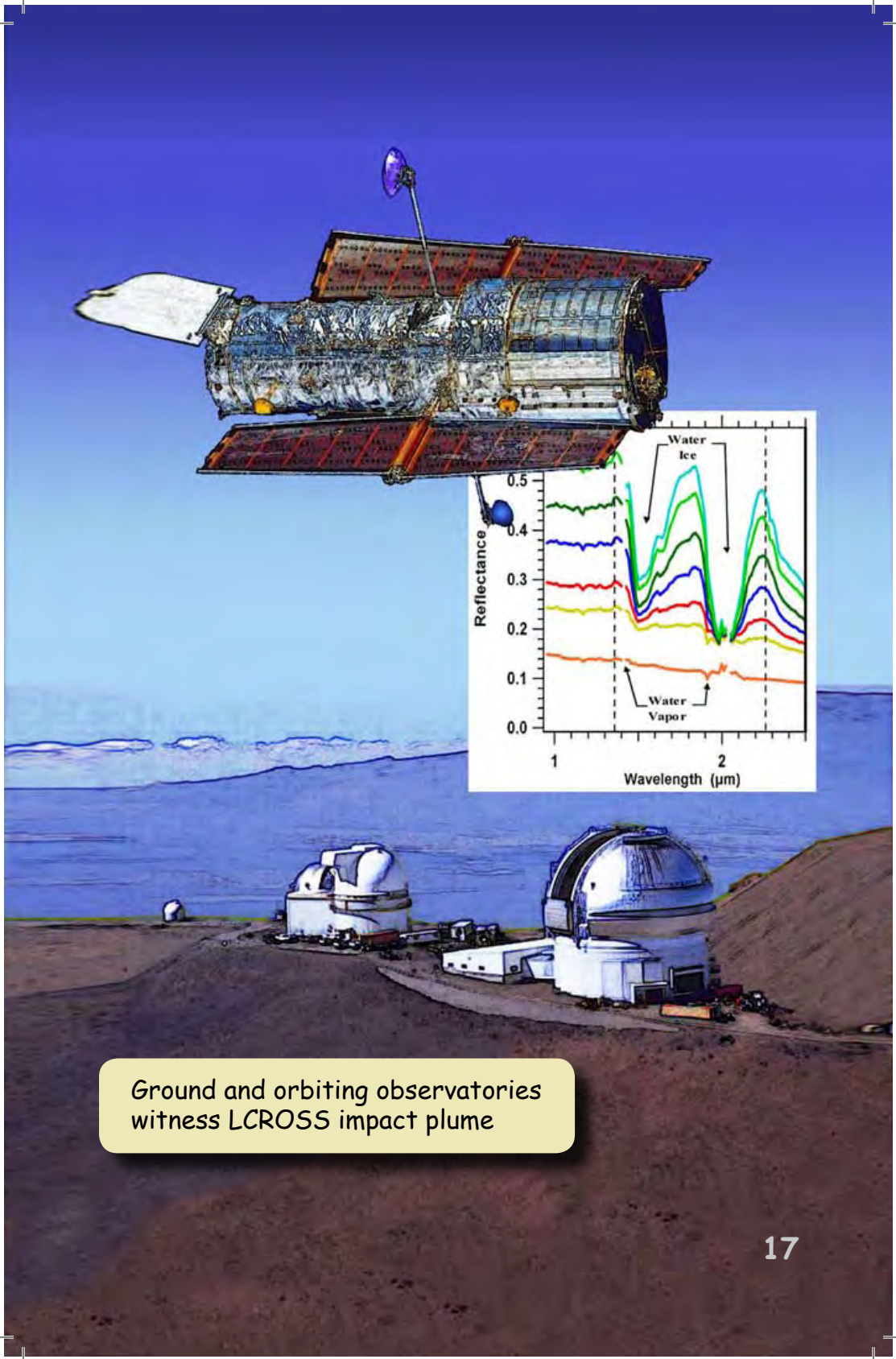
Upper Stage Impact


Upper Stage
Impact Flash



LCROSS spacecraft enters impact plume


LCROSS spacecraft descends through plume and impacts nearby



Ground and orbiting observatories witness LCROSS impact plume

The Moon is the Earth's nearest neighbor in space and the first stop in the human exploration of the solar system. The lunar surface of ancient volcanic flows is marked by large and small craters due to billions of years of bombardment by comets and asteroids. The existence of water on the Moon could affect the exploration strategy and base location.

The Clementine and Lunar Prospector missions, as well as Earth-based radar, indicate high concentrations of hydrogen (chemical element symbol "H") at the lunar poles. This is likely due to the presence of water ice (H_2O). If water exists there, it was probably deposited by ice-rich comets. Protected in permanently shadowed polar craters and insulating layers of dust, the water would not melt and evaporate or sublime away.

Artist concept of astronauts someday living on the Moon

After verification of lunar water, NASA will send rovers with drilling systems and analysis equipment to map the extent and quality of water on the Moon. In the meantime, The Lunar CRater and Observation & Sensing Satellite (LCROSS) and its launch vehicle upper stage will be targeted to impact a lunar polar crater. This will excavate a small crater and create a plume of chemicals, dust, and debris. The cloud will be analyzed for mineral and water content by LCROSS satellite spectrometers and infrared cameras, as well as ground-based telescopes.

LCROSS will be launched with the Lunar Reconnaissance Orbiter (LRO). LRO will simultaneously survey the lunar surface and generate maps of lunar surface characteristics and materials including hydrogen concentrations.

Lunar water, depending upon quantity and concentration, can be used for many aspects of astronaut life support. With enough electrical power (e.g., from solar energy collectors or nuclear generators) the water could be mined, transported, separated into hydrogen and oxygen, refrigerated, and used for rocket fuel.

LCROSS is a mission within the NASA Exploration Systems Mission Directorate.

Program Management
Lunar Precursor Robotic Program (LPRP)
Office at Marshall Space Flight Center
Project Management
NASA Ames Research Center
Mission and System Design
NASA Ames Research Center and Northrop Grumman
Mission Science
NASA Ames Research Center
Flight System Development
Northrop Grumman
Launch Vehicle
Atlas Centaur (United Launch Alliance)
Mission Operations
NASA Ames Research Center,
NASA Goddard Space Flight Center, and
NASA Jet Propulsion Laboratory
Co-Manifest Payload
Lunar Reconnaissance Orbiter (LRO)
by NASA Goddard Space Flight Center
Launch
In 2009 from Cape Canaveral, Florida
Mission Duration
Approximately 100 days, plus data analysis
LCROSS Spacecraft Mass
~650 kg without propellant, ~990 kg with Propellant
LCROSS Spacecraft Size
~2.0 m tall, ~2.6 m wide
Centaur Upper Stage Mass
~2000 kg (empty of propellant)
Launch Shroud Size
4 m in diameter

Distance from Earth

238,903 miles (384,476 kilometers)

Diameter

2,160 miles (3,476 km)

About one-fourth that of Earth

Surface Area

About equal to North and South America combined

Rotation Period

27.32 days

Surface Temperature

-300 to 260 degrees F (-185 to 127 degrees C)

Atmosphere

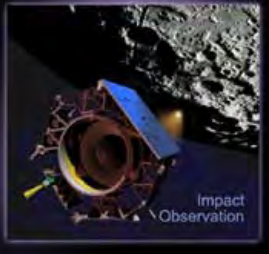
Almost negligible

Surface Composition

60% oxygen (in silicon dioxide) plus aluminum, calcium, iron, and magnesium, 5-10% each (in oxides)

Lunar Crater Observation & Sensing Satellite (LCROSS)

LCROSS



Developed by NASA Ames Research Center, LCROSS is a co-manifested spacecraft with the LRO (Lunar Reconnaissance Orbiter). The LCROSS mission objective is to look for water ice at one of the lunar poles.

LCROSS will be launched into a trans-lunar trajectory with the LRO satellite on an Atlas-Centaur rocket. The rocket will be launched from Cape Canaveral Air Force Station, Florida, in 2009.

Observing the impact of the rocket upper stage will help determine if there is water hidden in the permanently shadowed craters of one of the Moon's poles. If there are substantial amounts of ice there, it could be processed by astronauts to produce potable water, oxygen, and possibly even rocket fuel at future lunar bases.

For more information, go to: www.lcross.arc.nasa.gov

National Aeronautics and Space Administration
Ames Research Center
Moffett Field, CA 94035